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MORNINGSIDE EVALUATIONS AND CONSULTING

Megumi Nozawa

Signature of Translator

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SPECIFICATION

1. Title of the Invention
AMOROPHOUS ALLOY

2. What is claimed is:

Claim 1

An amorphous alloy comprising at least one of iron (Fe) and cobalt (Co), wherein a crystallization temperature is raised by adding at least one rare earth metal.

Claim 2

The amorphous alloy of Claim 1, wherein the amount of addition of said rare earth metals is no less than zero atom % but no more than six atom %.

Claim 3

The amorphous alloy of Claim 1 and Claim 2, wherein yttrium (Y) is added in addition to said rare earth metals.

Claim 4

The amorphous alloy of Claim 1, wherein yttrium (Y) is added in place of said rare earth metals.

3. Detailed Explanation of the Invention

The present invention relates to an amorphous alloy being stable and having a high crystallization temperature suitable as a magnetic material for electromagnetic converter devices such as a magnetic head.

Amorphous alloys, the principal component of which are transition metals such as iron (Fe) and cobalt (Co), and semi-metals such as silicon (Si), boron (B), and phosphorus (P), have been investigated and their respective features have been exploited for applications in many fields. However, there still remain major disadvantages in terms of properties desired as an amorphous alloy. That is, such disadvantages are crystallographic instability inherent in an

amorphous alloy, and magnetic instability arising from said crystallographic instability.

Treatment with heat at a suitable temperature has been known as an effective means for suppressing as much as possible said magnetic instability in an amorphous alloy. In such case, the higher the temperature in heat treatment, the more effectively stability can be provided. However, it is necessary to maintain the range of said temperature in heat treatment below the crystallization temperature Tx and above the Curie temperature Tc as well so as to suppress deterioration of magnetic properties as much as possible. Moreover, a material needs to satisfy the requirement, the crystallization temperature Tx being greater than the Curie temperature Tc. Therefore, with a material whose crystallization temperature Tx is less than its Curie temperature Tc, a special heat treatment process is required in addition to said heat treatment. However, no heat treatment process suitable for mass-manufacturing has been established yet.

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As one of said processes to raise a crystallization temperature Tx, it has shown that an addition of chromium (Cr), manganin (Mn), niobium (Nb), tangsten (W), tantalum (Ta), and the like is effective. However, even by said method, an increase in crystallization temperature Tx is about 50℃ at most, and the upper limit of said crystallization temperature is about 550℃.

Under said circumstances, the present invention was conducted. The purpose of the present invention is to provide an amorphous alloy comprising at least one of iron (Fe) and cobalt (Co), wherein said amorphous alloy has prominent soft magnetic properties with an extreme high crystallization temperature, a high magnetic flux density, a low coercivity, and a low magnetostriction constant by adding at least one rare earth metal at a level of no less than zero atom % but no more than six atom %.

Hereafter, examples of the present invention are explained by referring to the drawings.

Figure 1 illustrates the characteristics of changes both in crystallization temperature Tx and in Curie temperature Tc in relation to the amount of addition of samarium (Sm) y in the system expressed as the chemical formula $(Fe_xCo_{1-x})_{75-y}Sm_ySi_{15}B_{10}$. The solid lines in Figure 1 indicate changes in crystallization temperature Tx, and the dashed lines indicate changes in Curie temperature Tc. The lines (1) refer to the condition x = 0.30 in said chemical formula, and also the lines (2) refer to the condition x = 0.15.

It is apparent from Figure 1 that the crystallization temperature Tx remarkably increased by adding samarium (Sm); the crystallization temperature Tx reached almost to 700 ℃, and a change in Curie temperature was minimal, and hence the condition required for heat treatment (the crystallization temperature Tx > the Curie temperature Tc) can be readily attained.

Figure 2 illustrates a change in saturation magnetization per gram σs (emu/g) in relation to the amount of addition of samarium (Sm) y in the system expressed as the chemical formula $(Fe_xCo_{1-x})_{75-y}Sm_ySi_{15}B_{10}$, as in the case of Figure 1 abovementioned. The line (1) refers to the condition x = 0.30 in said chemical formula, and also the lines (2) refer to the condition x = 0.15.

Also, Figure 3 illustrates a change in magnetostriction constant λs

(emu/g) in relation to the amount of addition of samarium (Sm) y in the system expressed as the chemical formula $(Fe_xCo_{1-x})_{75-y}Sm_ySi_{15}B_{10}$. The line (1) refers to the condition x = 0.30 in said chemical formula, and also the lines (2) refer to the condition x = 0.15. It is apparent from Figure 3 that the magnetostriction constant λs decreased by adding samarium (Sm), and especially $\lambda s < 1 \times 10^{-6}$ was attainable by the addition of two atom % or more under the condition (2).

Figure 4 illustrates a change in coercivity Hc at ambient temperature in relation to the heat treatment temperature Ta (℃) in the system expressed as the chemical formula $(Fe_{0.15}Co_{0.85})_{72.7}Sm_{2.3}Si_{15}B_{10}$. It is apparent from Figure 4 that the corcivity Hc was rendered to be no more than 100 milioersted by heat treatment. With the composition expressed as said chemical formula, a saturation magnetization σs is 75 emu/g, as shown in Figure 2, and a saturation magnetic flux density Bs is no less than 9,000 gauss. Therefore, this can be a remarkable soft magnetic material.

Furthermore, the foregoing examples, wherein samarium (Sm) was added, are explained, but it is confirmed that the same effects can be provided with cerium (Ce) in place of samarium (Sm) abovementioned. In such case, preparation of the sample is easier than that with samarium (Sm). Moreover, when yttrium (Y), whose physical properties are similar to those of rare earth metals, is used in addition to or in place of said rare earth metal, it is also confirmed that said same effects can be obtained.

With accordance with the present invention, as mentioned above, an amorphous alloy comprising at least one of iron (Fe) and cobalt (Co) can be provided, wherein said amorphous alloy has prominent soft magnetic properties with an extreme high crystallization temperature, a high magnetic flux density, a low coercivity, and a low magnetostriction constant by adding at least one rare earth metal or yttrium (Y). For example, in application for an electromagnetic converter device such as a tape head, compared to an amorphous alloy matereial with no rare earth metals comprising iron (Fe), cobalt (Co), silicon (Si), and boron (B), the amorphous alloy, from which devices having greater stability can be obtained, can be provided.

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Furthermore, the present invention should not be limited to said application as a magnetic material, but can also provide an amorphous alloy material having a great stability, and various modifications are permitted as long as other requirements are satisfied.

4. Brief Description of the Drawings

Figure 1 illustrates the characteristics of changes in crystallization temperature Tx and in Curie temperature Tc in relation to the amount of addition of samarium (Sm) y in the system expressed as $(Fe_xCo_{1-x})_{75-y}Sm_ySi_{15}B_{10}$. Figure 2 illustrates a change in saturation magnetization σs in relation to the amount of addition of samarium (Sm) y in the same system as in Figure 1 abovementioned. Figure 3 illustrates a change in magnetostriction constant λs in relation to the amount of addition of samarium (Sm) y in the same system as in Figure 1 abovementioned. Figure 4 illustrates the characteristics of a change in coercivity Hc at ambient temperature in relation to the heat treatment temperature Ta (℃) in the system expressed as $(Fe_{0.15}Co_{0.85})_{72.7}Sm_{2.3}Si_{15}B_{10}$.

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Figure 1

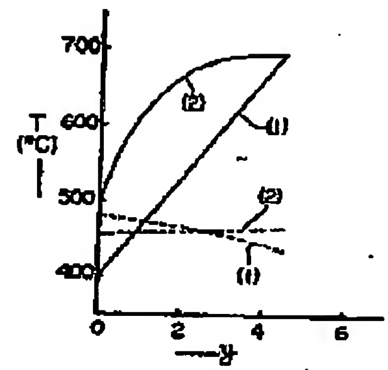

Figure 2

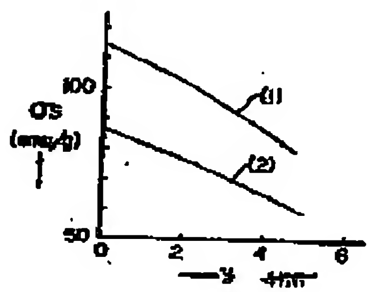

Figure 3

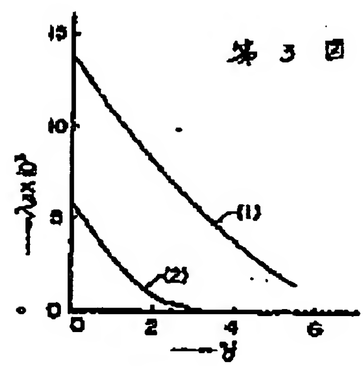

Figure 4

Hc (milioersted)